PATENT ABSTRACTS OF JAPAN

(11)Publication number : 05-071428
(43)Date of publication of application : 23.03.1993

(51)Int.Cl. F02M 25/07
F02M 25/07
F02M 25/07

(21)Application number : 03-259858
(22)Date of filing : 10.09.1991

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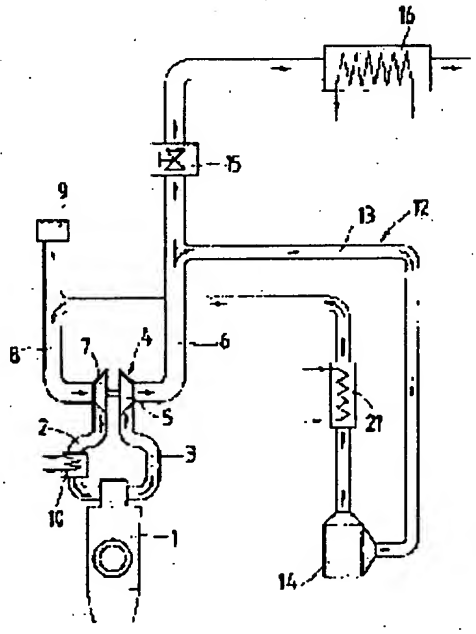
(54) EXHAUST GAS REFLUX DEVICE OF DIESEL ENGINE

(57)Abstract:

PURPOSE: To obtain the optimum EGR gas reflux pressure for decreasing a quantity of NOx by providing a soot trap and a gas cooler, and also providing an exhaust pressure control valve on the way of an EGR gas reflux circuit which forces exhaust gas downstream of an exhaust turbine supercharger to flow back to the intake side.

CONSTITUTION: The inlet part of an EGR gas pipe 13 which constitutes an EGR gas reflux circuit 12 is connected to the middle of an exhaust pipe 6, in a diesel engine equipped with an exhaust turbine supercharger 4, and the outlet side of the EGR gas pipe 13 is connected to the middle of an intake pipe 2 via a soot trap 14 and an EGR gas cooler 21 on the way thereof.

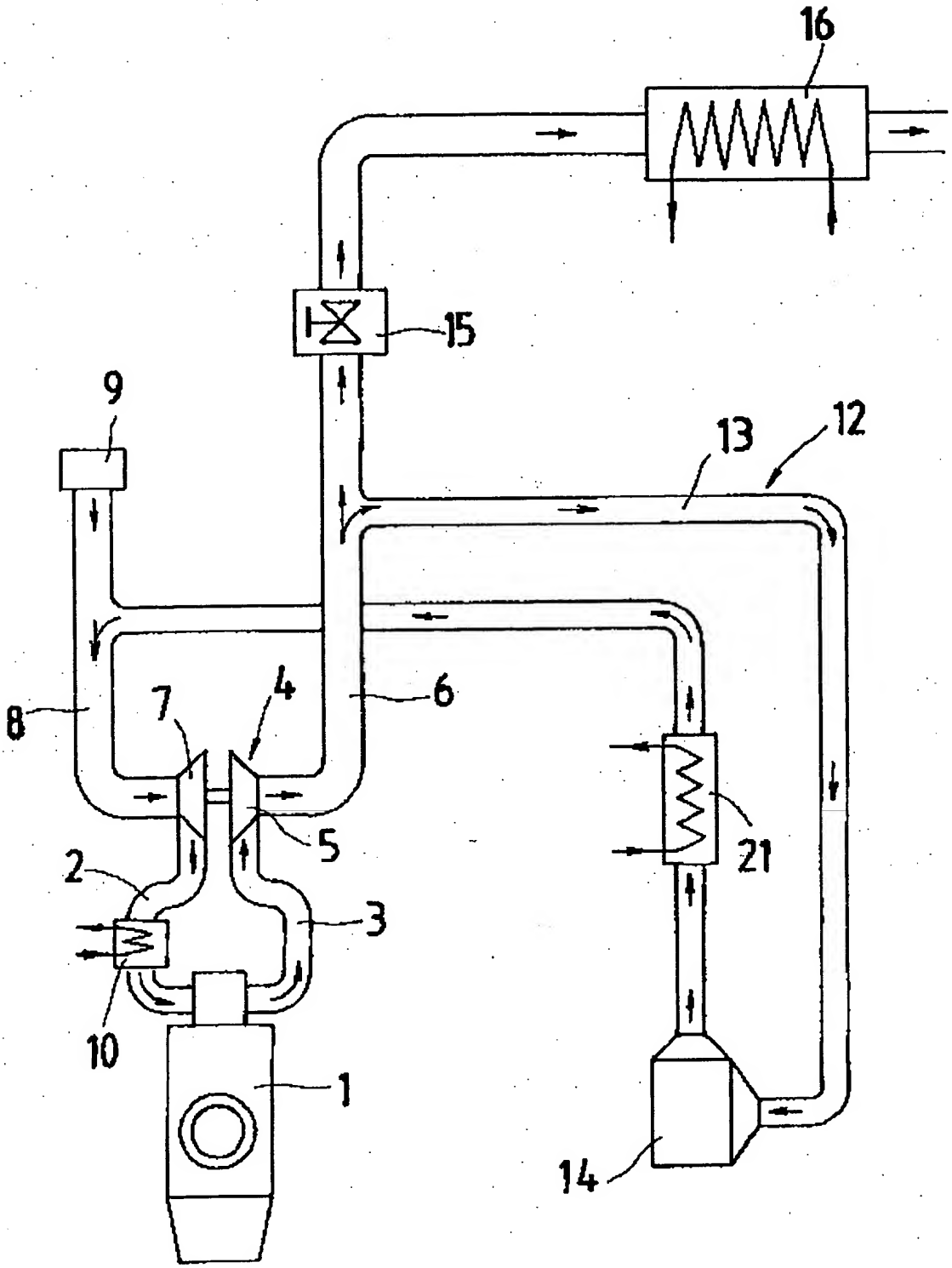


Consequently, the exhaust gas in the exhaust gas pipe 6 is forced to flow back to an intake pipe 8 in front of a blower 7 as the EGR gas. A variable exhaust pressure control valve 15 which can vary continuously a quantity of the exhaust gas which flows through the exhaust pipe 6, is provided on the way of the exhaust pipe 6 located downstream from the connection part of the EGR pipe 13, and the exhaust gas pressure forced to flow back to the EGR gas

pipe 13 is controlled by adjusting the valve 15.

LEGAL STATUS

[Date of request for examination]	05.02.1998
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	3038512
[Date of registration]	03.03.2000
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	03.03.2004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* NOTICES *

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2.**** shows the word which can not be translated.
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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the exhaust gas reflux equipment (EGR equipment) used mainly for the Diesel engine of a fixed mold.
[0002]
[Description of the Prior Art] It is known by making exhaust gas flow back to an inspired air flow path that NOx can be reduced.
[0003] In the engine having such EGR equipment, when reflux gas will be taken out from the turbine upstream of a supercharger, there is un-arranging [to which a turbine efficiency falls]. Then, although an EGR gas reflux circuit is connected to the turbine downstream of the supercharger and the exhaust gas of the downstream is made to flow back in an engine with a supercharger, since it is after being consumed in a turbine, there is a problem that reflux pressure with it is not obtained. [low gas pressure and] [sufficient]
[0004] Then, while taking out EGR gas from the lower stream of a river which is a supercharger outlet side and making a blower inlet port flow back conventionally, back pressure is turned on and off in the time of an idling and load operation, and there is a thing which enabled it to obtain required reflux gas pressure. On the other hand, although it was already well-known to have attached a soot trap and an EGR gas cooler, there was nothing that was combined with these.
[0005]
[Problem(s) to be Solved by the Invention] As mentioned above, in the former, prepare a back pressure bulb in the downstream of an EGR gas reflux circuit, he is trying to obtain sufficient reflux gas pressure, and required gas pressure can be obtained by this. Generally, if it is in the inclination to fall, so that there are many amounts of EGR gas reflux and it carries out from this, NOx in exhaust gas will be good, so that it sets up many amounts of reflux by the back pressure bulb. However, the yield of NOx, fuel consumption, and the yield of a black smoke had the relation which generally conflicts, and had the fault that this control could not be performed, by some which are simply turned on and off like said before to controlling to obtain the optimal amount of EGR gas reflux according to the terms and conditions of engines, such as a load.
[0006] That is, the above-mentioned conventional back pressure bulb is a thing aiming at attaching in an automobile engine, and it is supposed in a certain transit mode that what is necessary is just the control criteria of NOx for automobiles below the decided amount. Since it will become disadvantageous from such a viewpoint on an output if EGR is used in car motor even when a full load is applied, he closes a bulb and is trying for EGR not to start. That is, it was the purpose which is used at the time of an idling, and it was enough as EGR of car motor just to make it flow back directly, without moreover performing special control.
[0007] On the other hand, with the engine for stationing, no matter what usage [the bottom of what kind of condition, or] it may carry out It is needed that it is below a constant rate and are necessary to acquire the best NOx reduction effectiveness according to these. It is necessary to perform suitable control,

reduction of NOx at the time of a full load being most needed with the engine of a fixed mold unlike car motor, and taking into consideration the problem of fuel consumption or a black smoke rather.
[0008] By supposing that EGR gas is taken out from the blower lower stream of a river of a supercharger, preparing an adjustable back-pressure control bulb in the downstream, and preparing an EGR rate control bulb also all over an EGR gas reflux circuit further from that takeoff connection, the purpose of this invention is in the point of enabling it to obtain the optimal EGR gas reflux pressure, in order to reduce NOx. Furthermore, enabling it to obtain the optimal ring current gas pressure by adjusting the above-mentioned bulb according to the conditions of a load or others according to them is also included.
[0009]
[Means for Solving the Problem] While preparing the EGR gas takeoff connection to an inspired air flow path in the blower downstream of a supercharger, an adjustable back-pressure control bulb is prepared all over a down-stream flueway, and it enables it to change the amount of reflux of exhaust gas by this rather than that takeoff connection further in this invention, in order to attain the above-mentioned purpose. In that case, the opening volume of the back-pressure control bulb is controlled by carrying out sensing of the exhaust-air-pressure force etc., and the optimal EGR gas reflux pressure carries out for obtaining by it. On the other hand, it enables it to perform high control of precision more by preparing the EGR control bulb for fine tuning also all over an EGR gas reflux circuit.
[0010] Moreover, in order to process exhaust gas, the soot trap and EGR gas cooler for soot dust removal are formed. Furthermore, it is possible to prepare the bypass circuit which can make the exhaust gas of the bypass circuit along which an EGR gas cooler does not pass in order to raise an intake-air temperature at the time of low starting of an intake-air temperature etc., the turbine lower stream of a river of a supercharger, or the upstream flow back to a direct inspired air flow path. On the other hand, since cooling of EGR gas is promoted and the yield of NOx is reduced more, it is possible to form the turbo cooling equipment which EGR gas is compressed and expanded and is cooled.
[0011] Furthermore, there is a control means performed by detecting an engine's load or fuel consumption further by detecting the control means performed by detecting the NOx concentration of the gas by which control of a back-pressure control bulb and an EGR rate control bulb flows back to the exhaust-air-pressure force and an inspired air flow path in the above, the control means performed by detecting the carbon dioxide gas or the oxygen density of an inspired air flow path the inside of an EGR gas reflux circuit, atmospheric temperature, humidity, and atmospheric pressure.
[0012]
[Example]
<Explanation of the circuit of drawing 1 > As for an engine and 2, in a Fig., 1 is [the inlet manifold of the engine 1 and 3] exhaust manifolds. 4 is an exhaust turbosupercharger, the turbine 5 is attached in the connection of an exhaust manifold 3 and an exhaust pipe 6, and the blower 7 is attached in the connection of an inlet manifold 2 and an inlet pipe 8. 9 is the air cleaner attached in inhalation opening of an inlet pipe 8. Moreover, the intercooler 10 is infixed in the middle of the inlet manifold 2. Although the inlet-port section of the EGR gas tubing 13 which constitutes the EGR gas reflux circuit 12 is connected in the middle of the exhaust pipe 6, he connects in the middle of an inlet pipe 2, and is trying for the outlet side of the EGR gas tubing 13 to make the exhaust gas in an exhaust pipe 6 flow back to the inlet pipe 8 of blower 7 this side as EGR gas by this through the EGR gas cooler 21 of intermediate soot trap 14 and soot trap 14 lower stream of a river. And rather than the connection of the above-mentioned EGR gas tubing 13, the adjustable back-pressure control bulb 15 which can change into a stepless story the amount of the exhaust gas which flows that exhaust pipe 6 in the middle of the down-stream exhaust pipe 6 is formed, and the exhaust-air-pressure force which flows back to the EGR gas tubing 13 is controlled by adjusting this back-pressure control bulb 15. In addition, the exhaust air economiser 16 which takes out the heat used for the equipment of a calorifier and others by heat exchange with the exhaust gas in the middle of the down-stream exhaust pipe 6 from the back-pressure control bulb 15 is attached.
[0013] <Explanation of the circuit of drawing 2 > Drawing 2 is the circuit diagram which attached the

bypass circuit 20 of the HC heater 19 and the EGR gas cooler 21, and the steam separator 22 in the circuit of said drawing 1 further. A steam separator 22 is attached in the lower stream of a river of the EGR gas cooler 21, and it carries out separation / reduction processing, and he is trying to form the HC heater 19 in the middle of the EGR gas tubing 13 in the upstream of the soot trap 14, and to discharge the acid water of condensation generated in the case of cooling by the gas cooler 21. According to the temperature of EGR gas, when temperature is high, the closing motion valve 18 for passing the EGR gas cooler 21, and making the whole quantity bypass, when low is attached in the bypass circuit 20 which bypasses the EGR gas cooler 21.

[0014] Furthermore, the EGR rate control bulb 26 for fine control (for fine tuning) for controlling the amount of EGR gas reflux more finely according to a load is formed in the downstream of the above-mentioned steam separator 22.

[0015] Moreover, rather than the inlet port of the above-mentioned EGR gas tubing 13, it branches from the middle of the upstream exhaust pipe 6, and in order to make the gas in the exhaust pipe 6 flow back directly to a blower 7 side without letting said HC heater 19, the soot trap 14, and a steam separator 22 pass, the direct reflux bypass circuit 23 equipped with the change bulb is connected and established in the upstream of said EGR rate control bulb 26. This bypass circuit 23 is used for the same purpose as the circuit 20 which bypasses the above-mentioned EGR gas cooler 21, since especially this circuit 23 does not pass along the part used as resistance of paths, such as the soot trap 14, the HC heater 19, and a steam separator 22, it is an elevated temperature more and it can obtain the efficient amount of reflux. That is, although an ignition delay becomes long, NOx will get worse on the contrary or unburnt hydrocarbon will increase if it cools also in the time of a low load, although there are some which delayed fuel injection timing for the cure against NOx with the latest engine, it can prevent such un-arranging by forming this bypass circuit 23. In this case, as the broken line of drawing shows, forming this bypass circuit 23 so that it may be made to flow back from a near side from the turbine 5 of a supercharger is also considered. Since the exhaust gas before temperature falls in a turbine 5 is made to flow back when it does in this way, hotter EGR gas can be obtained and it is effective in the engine performance at the time of startability and a low load being more improvable.

[0016] The soot trap 14 is for taking only solid-state-like soot, and since gas-like HC passes, in order that it may prevent it liquefying and adhering all over a duct, it forms said HC heater 19 and he is trying to burn it beforehand fundamentally in the above. Although there are some which the party curate trap means using an oxidation catalyst generally needed to make the exhaust-gas temperature high, therefore formed the heater, in this case, only HC is burned and it is made to carry out uptake of others by the soot trap 14.

[0017] Into the exhaust pipe 6 in the upstream of the back-pressure control bulb 15, the pressure sensor 24 which detects the back pressure in the exhaust pipe 6 is attached, and he is trying to control the opening of the back-pressure control bulb 15 by feeding back the detection result of the detection sensor 24 to the back-pressure control bulb 15, so that an EGR gas pressure serves as a suitable value.

[0018] Furthermore, the NOx sensor 25 which detects the NOx concentration of the exhaust gas which flows that exhaust pipe 6 is formed into the exhaust pipe 6 in the upstream rather than the inlet port of the EGR gas tubing 13, and the amount of reflux of EGR gas is finely tuned by feeding back the detection result of this sensor 25 to the EGR rate control bulb 26. That is, although a certain amount of control is possible by making the yield of NOx control by said back-pressure control bulb 15 to make the EGR gas of the target amount flow back, the control with a precision high so then is difficult, and optimal control according to fluctuation of a load etc. can be performed by carrying out direct detection of NOx in reflux gas, and tuning finely further by the EGR rate control bulb 26. Since the controlled variable of especially the back-pressure control bulb 15 is large, it is effective to a rapid load effect.

[0019] <Explanation of the circuit of drawing 3 > Drawing 3 forms the turbo cooling equipment 29 which is the circuit diagram showing other examples of an EGR gas cooling system, and becomes the lower stream of a river from a blower 30 and a turbine 31 in addition to the above-mentioned EGR gas cooler 21, and it is made to make low-temperature EGR gas flow back more. That is, the blower 30 is cooled by compressing the reflux gas at the same time it drives an EGR gas circuit by the flowing reflux

gas, and expanding in a turbine 31. Moreover, he is trying to cool the compressed gas preparatorily by forming an after-cooler 32 all over the path from a blower 30 to a turbine 31. Of course, in order [to which the inhalation of air at the time of starting is supercooled, and startability worsens like the above, or EGR effectiveness falls conversely] to carry out thing prevention, it is desirable to establish the bypass circuit 33 in the location shown with the broken line of drawing.
[0020] <Explanation of control of drawing 4 > Drawing 4 shows the example in the case of performing control of the opening of said back-pressure control bulb 15 and the EGR rate control bulb 26 using a microcomputer. the 2nd gas concentration sensor which similarly prepared down-stream the 1st gas concentration sensor which prepared 35 in the upstream of the EGR rate control bulb 26 of an EGR gas reflux circuit, and 36 in drawing -- it is -- the former 35 -- O2 or CO2 in reflux gas -- detecting -- the latter 36 -- the gaseous mixture of inhalation air and reflux gas -- inner O2 or inner CO2 is detected, and the value is inputted into a microcomputer 37. And after a microcomputer 37 calculates based on the inputted value, it outputs a control signal to each control bulbs 15 and 26, and it adjusts those bulb opening so that it may become the optimal EGR rate. In this case, when an EGR rate is set to ER, EGR rate ER is expressed with a degree type.
[0021]
[Equation 1]
Ve =Va +Vg (1)
[0022]
[Equation 2]
Ve [O2] e =Va [O2] a+Vg [O2] g (2)
[0023]
[Equation 3]
Ve [O2] e =Va [CO2] a+Vg [CU2] g (3)
[0024]
[Equation 4]
ER=Vg /Ve (4)
[0025] It is here and is [0026]. V: Capacity [m3/h]
[0027] ER: EGR rate [0028] [O2]: Oxygen density [%]
[0029] [CO2]: Carbon dioxide levels [%]
[0030] e : inspired gas after EGR gas mixing [0031] : new mind air before EGR gas mixing [0032] g : EGR gas [0033] It is [0034] from (1), (2), and (4).
[Equation 5]
ER=[O2] a-[O2] e / [O2] a- [O2] g =21-[O2] e / 21-[O2] g (5)
[0035] Similarly, it is [0036].
[Equation 6]
ER=[CO2] e/[CO2] g (6)
[0037] Thus, the difference between the acquired current EGR rate and the target EGR rate set up beforehand is searched for, and bulb opening is controlled by this to become the target EGR rate. Drawing 5 shows the flow chart of the control about the back-pressure control bulb 15.
[0038] In addition, since the above-mentioned sensors 35 and 36 are formed down-stream rather than the HC heater 19 and the soot trap 14, they can prevent adhesion of carbon etc. and can obtain high control of precision.
[0039] <Explanation of control of drawing 6 > Instead of detecting the above-mentioned gas concentration, drawing 6 carries out sensing of either [either / both sides or] the fuel consumption of the ambient condition and engine which consist of an atmospheric pressure, temperature, and humidity, or a load, and controls it. That is, NOx tends to be affected by ambient conditions else [, such as a load,], such as atmospheric pressure and temperature, and can be controlled also by detecting these. The sensor by which 39 detects a load or fuel consumption, and 40 are sensors which detect atmospheric temperature, humidity, and atmospheric pressure, and they input these detection values into a microcomputer 37, and he is trying to control the back-pressure control bulb 15 and the EGR rate

control bulb 26 in the circuit of drawing 6 based on the result.
[0040] By showing the flow chart of the control and inputting atmospheric temperature, atmospheric pressure and humidity, fuel consumption, or a load first, drawing 7 calculates the weight of the moisture in the inhalation air inhaled, the atmospheric air 9, i.e., the air cleaner, at that time, (step S1), and computes the amount of the moisture in EGR gas based on another side, the inputted load, or fuel consumption (step S3). Furthermore, the load or fuel consumption determines the amount of target EGR gas reflux according to the load or fuel consumption based on an operation or the data decided beforehand (step S2). the gaseous mixture of after an appropriate time and inhalation air and EGR gas -- it asks for the sum of the amount of inner moisture, and the weight of the moisture in inhalation air (step S4), while this determines the amount EGR1 of target EGR(s), the desired value and said assumed amount of EGR(s) are measured (step S 5 six), and the opening of the EGR rate control bulb 26 is controlled to agree in it (step S7). thus, computing moisture from atmospheric temperature, fuel consumption, etc. -- the yield of NOx -- gaseous mixture -- it is it being tended to influence the amount of inner moisture and increasing the amount of EGR reflux gas according to the amount of the moisture, and is because it becomes possible to control to bulb opening with least generating of NOx.
[0041] Of course, although best measures directly and controls NOx also in any of control of above-mentioned drawing 5 and drawing 7 , it is still cheap, is difficult for an accurate NOx sensor to come to hand, is using it as these substitution properties, and can control with a comparatively sufficient precision by low cost.
[0042]
[Effect of the Invention] According to this invention, the following effectiveness is acquired.
** Since the adjustable back-pressure control bulb is prepared down-stream rather than the EGR reflux circuit of a flueway, unlike what was simply branched from the flueway, sufficient amount of EGR(s) can be obtained, increase the reduction effectiveness of NOx, and it becomes possible to obtain the optimal reasonable amount of EGR(s) according to a load etc. by carrying out adjustable control of this control bulb moreover.
[0043] ** In the above, since the soot trap and gas cooler from which the soot dust in exhaust gas is removed are formed in the EGR gas reflux circuit, more effective EGR control can be performed by combining these with said back-pressure control bulb.
[0044] ** Since the EGR rate control bulb for the inside of an EGR gas reflux circuit to perform detailed control is prepared further, control of the amount of EGR(s) with a difficult high precision can be performed only by the back-pressure control bulb.
[0045] ** Since the bypass circuit which can bypass an EGR gas cooler is prepared, startability ability and the engine performance at the time of a low load can be secured by letting this bypass circuit pass at the time of low starting of an exhaust-gas temperature etc., without reducing EGR effectiveness.
[0046] ** Not only the above-mentioned cooler but a soot trap etc. is bypassed, the bypass circuit made to flow back directly from the lower stream of a river or the upstream just behind the turbine of a supercharger is prepared, at the time of starting and a low load etc., loss by resistance of an EGR circuit can be avoided and efficient EGR can be performed again.
[0047] ** By controlling the above-mentioned back-pressure control bulb and an EGR rate control bulb based on the NOx concentration in exhaust gas pressure and an EGR circuit, the always suitable amount of EGR reflux can be obtained, and effective EGR control is attained.
[0048] ** It is not necessary to use an expensive NOx sensor, and a cheap control unit can be obtained again by controlling the amount of EGR(s), using O2 or CO2 concentration in exhaust gas and atmospheric air as a substitution property of NOx.
[0049] ** A cheap control unit can be obtained by using an ambient condition or fuel consumption, such as atmospheric temperature and humidity, and a load as a substitution property of NOx similarly.
[0050] ** Since turbo cooling equipment is formed in the EGR gas reflux circuit, while being able to ** as if the EGR gas of nearby low temperature can be obtained and decline in EGR effectiveness is prevented from the case of only the usual cooler, the cooling system itself can be used as a compact.

[Translation done.]

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CLAIMS

[Claim(s)]
[Claim 1] In the Diesel engine having an exhaust turbosupercharger, the EGR gas reflux circuit for making the exhaust gas of the above-mentioned supercharger lower stream of a river flow back to an inspired air flow path is prepared. All over this EGR gas reflux circuit While forming a gas cooler as well as the soot trap which removes the soot dust of the gas in the circuit Furthermore, Diesel engine exhaust gas reflux equipment characterized by preparing the back-pressure control bulb which carries out adjustable control of the reflux pressure to said EGR gas reflux circuit all over a down-stream flueway rather than the inlet port of the above-mentioned EGR gas reflux circuit.
[Claim 2] Diesel engine exhaust gas reflux equipment according to claim 1 characterized by preparing the bypass circuit which bypasses the EGR gas cooler in an EGR gas reflux circuit.
[Claim 3] Diesel engine exhaust gas reflux equipment according to claim 1 or 2 characterized by preparing the bypass circuit which can make exhaust gas flow back from the turbine lower stream of a river or the upstream of a supercharger to a direct inspired air flow path without letting said soot trap and an EGR gas cooler pass.
[Claim 4] The Diesel engine exhaust gas reflux equipment according to claim 1 characterized by similarly to prepare the EGR rate control bulb which tunes the quantity of gas flow in the circuit finely all over an EGR gas reflux circuit while preparing the EGR gas reflux circuit for making the exhaust gas of the above-mentioned supercharger lower stream of a river flow back to an inspired air flow path in the Diesel engine having an exhaust-gas-turbine supercharger and preparing the back-pressure-control bulb which carries out adjustable control of the reflux pressure to said EGR gas reflux circuit all over a down-stream flueway rather than the inlet port of the EGR gas reflux circuit.
[Claim 5] Diesel engine exhaust gas reflux equipment according to claim 1 characterized by forming the turbo cooling equipment which replaces with an EGR gas cooler in addition to the EGR gas cooler in the circuit, and is cooled by compression and expansion of gas all over an EGR gas reflux circuit.
[Claim 6] Diesel engine exhaust gas reflux equipment according to claim 3 characterized by controlling a back-pressure control bulb according to the detection result of a pressure sensor, and controlling an EGR rate control bulb according to the detection result of an NOx sensor while forming the pressure sensor which detects the exhaust gas pressure in a flueway, and the NOx sensor which similarly detects the NOx concentration in an EGR gas reflux circuit [claim 7] Diesel engine exhaust gas reflux equipment according to claim 3 characterized by forming the control device which controls an EGR rate according to the detection result detected by those concentration sensors while forming the 1st concentration sensor which detects the carbon dioxide gas in an EGR gas reflux circuit, or the concentration of oxygen in the lower stream of a river of an EGR gas cooler and forming the 2nd concentration sensor which detects the carbon dioxide gas under inhalation of air, or the concentration of oxygen in the blower lower stream of a river of a supercharger.
[Claim 8] Diesel engine exhaust gas reflux equipment according to claim 3 characterized by establishing the control means which is equipped with a detection means to detect either [either / both sides or] a detection means to detect ambient conditions, such as atmospheric temperature, humidity, or

atmospheric pressure, and an engine's load or fuel consumption, and controls a back-pressure control bulb and an EGR rate control bulb according to the detection means by these detection means.

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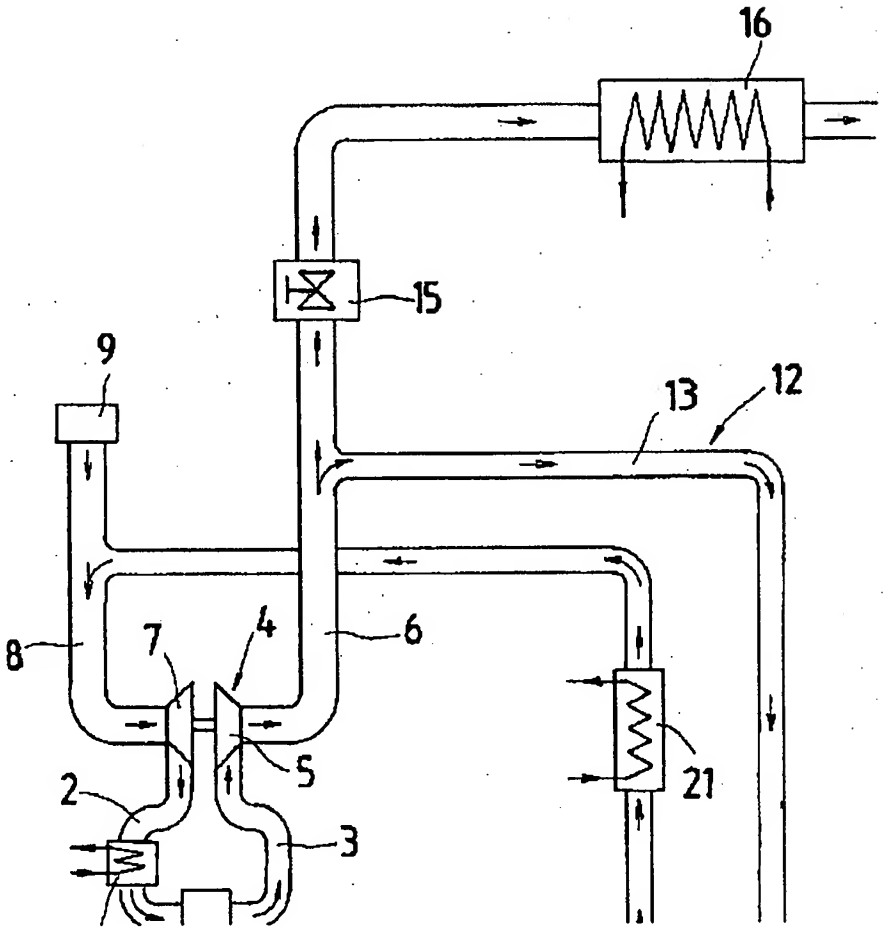
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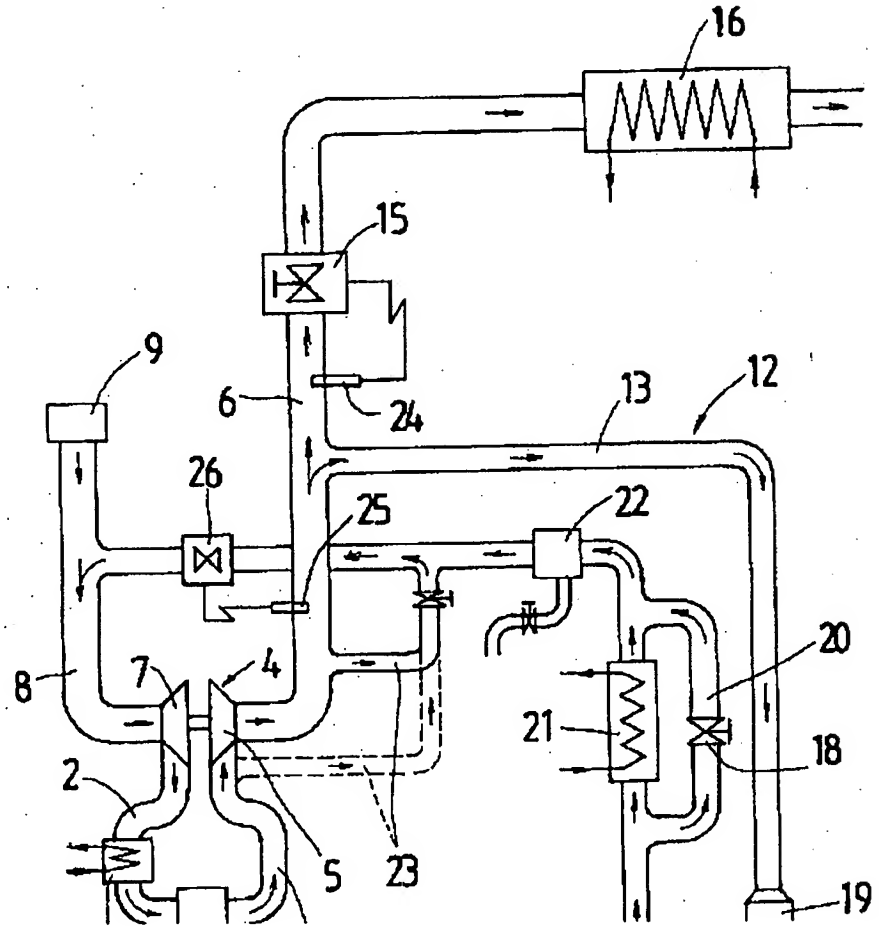
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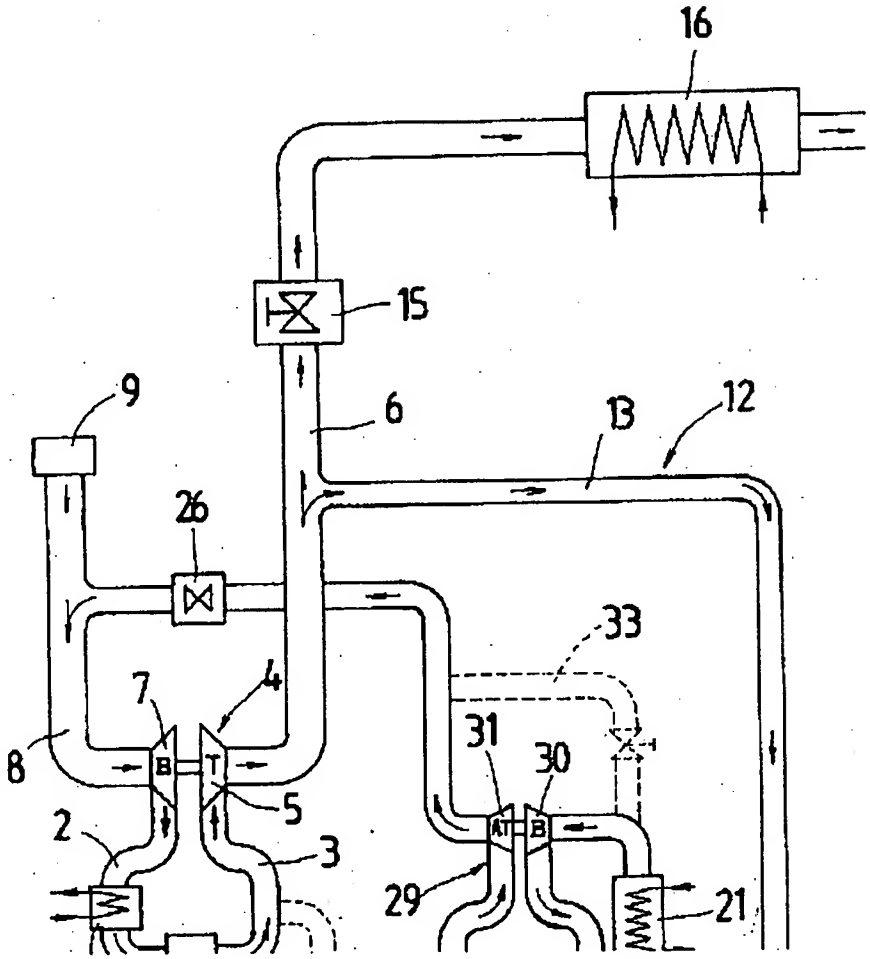
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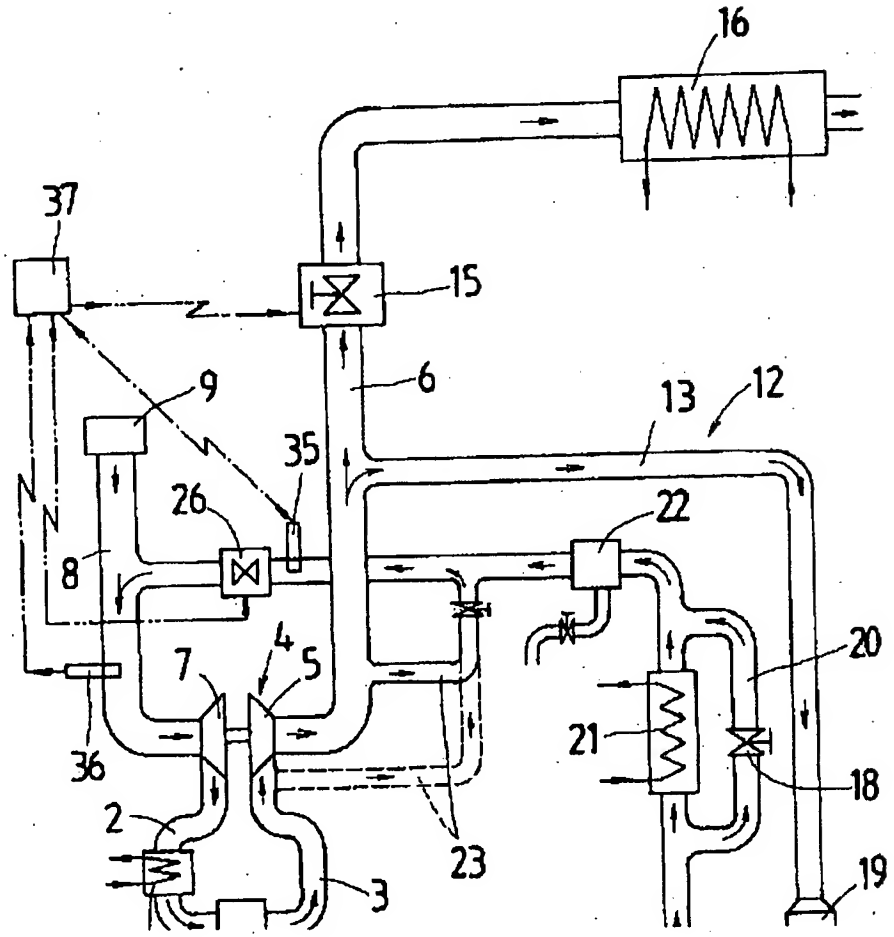
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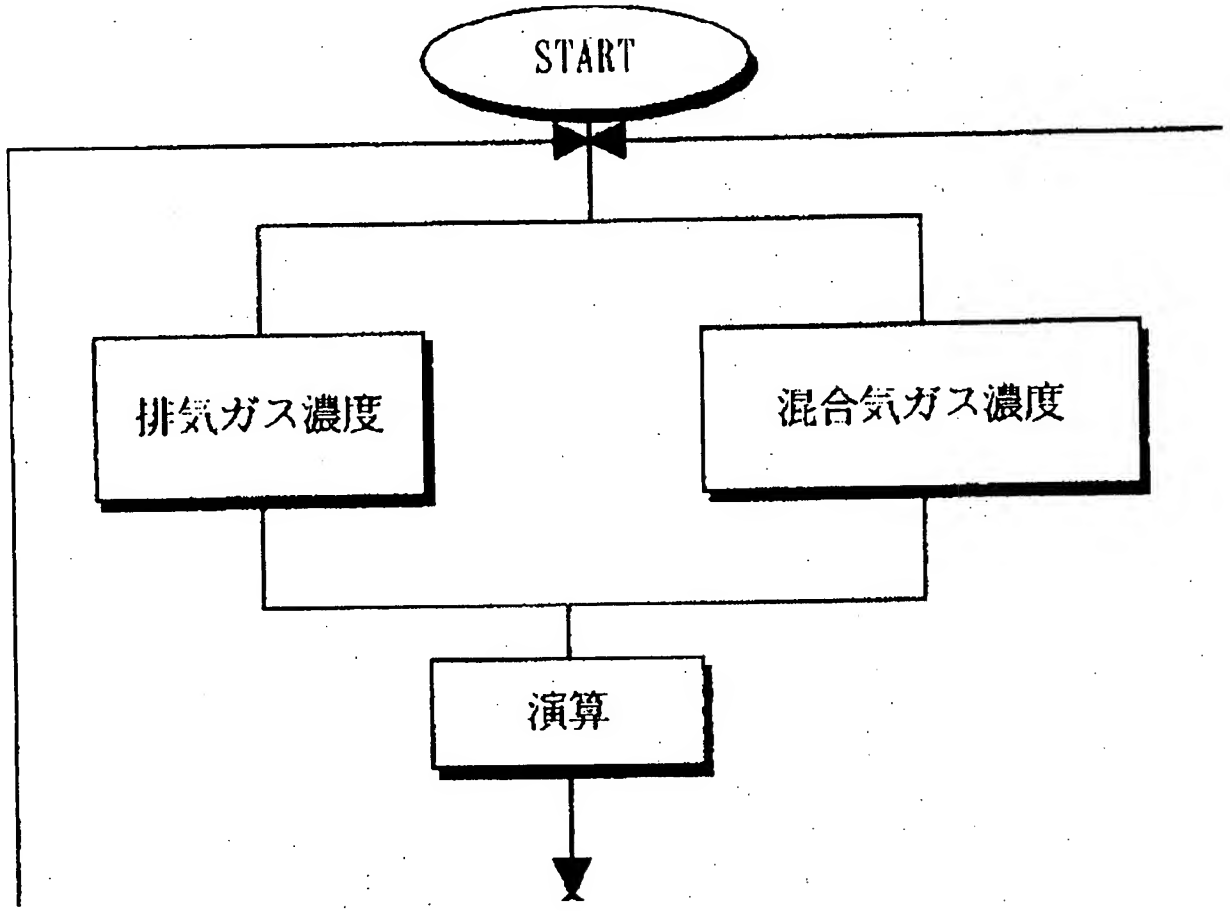
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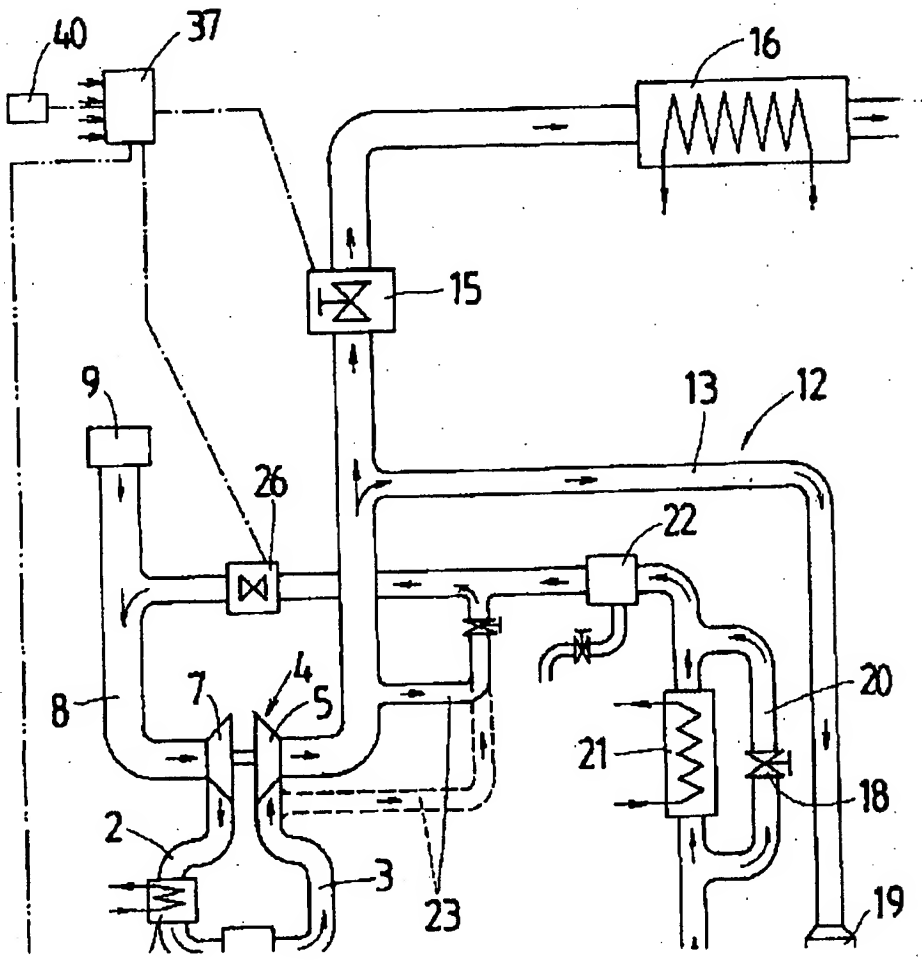
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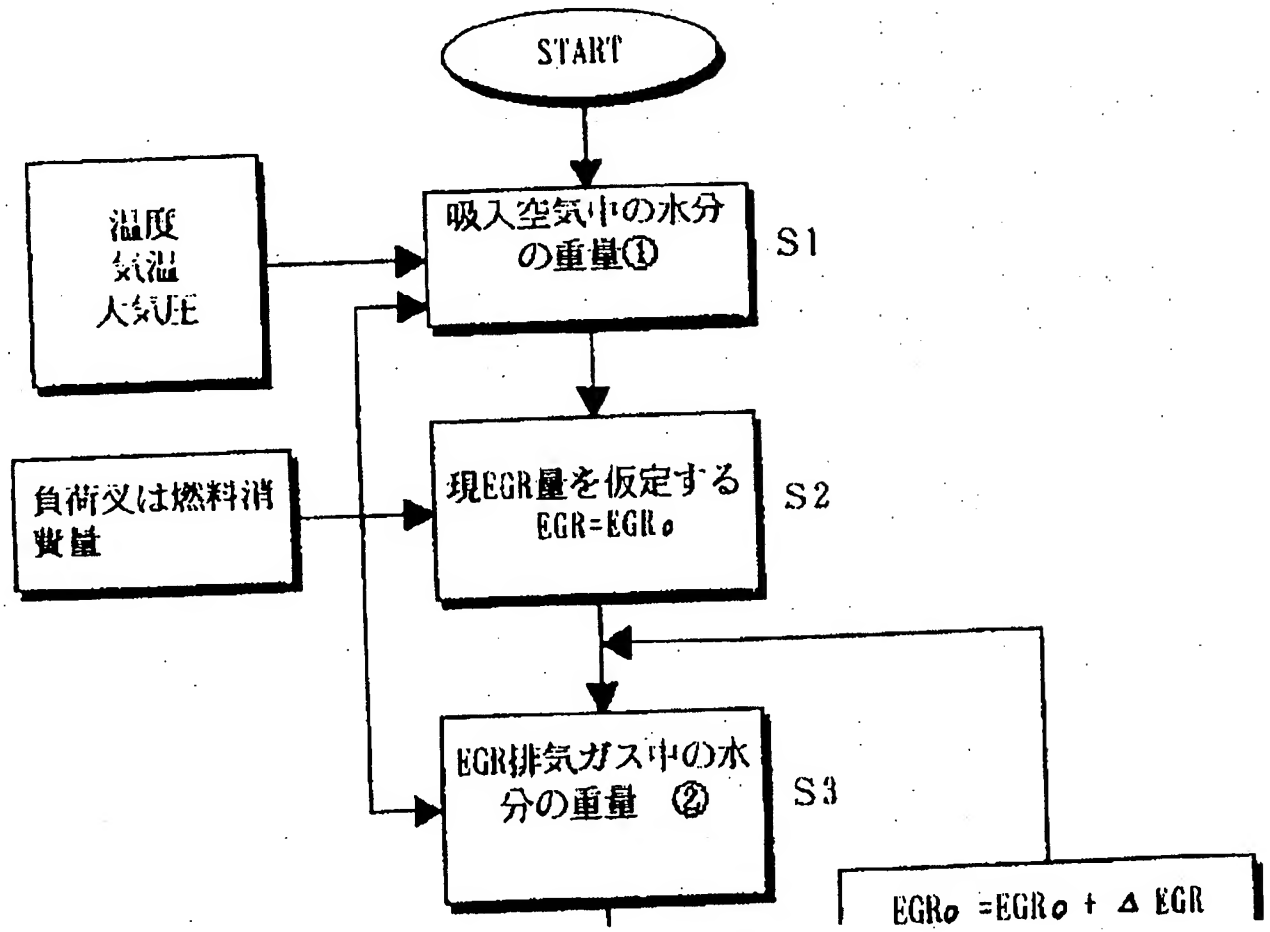
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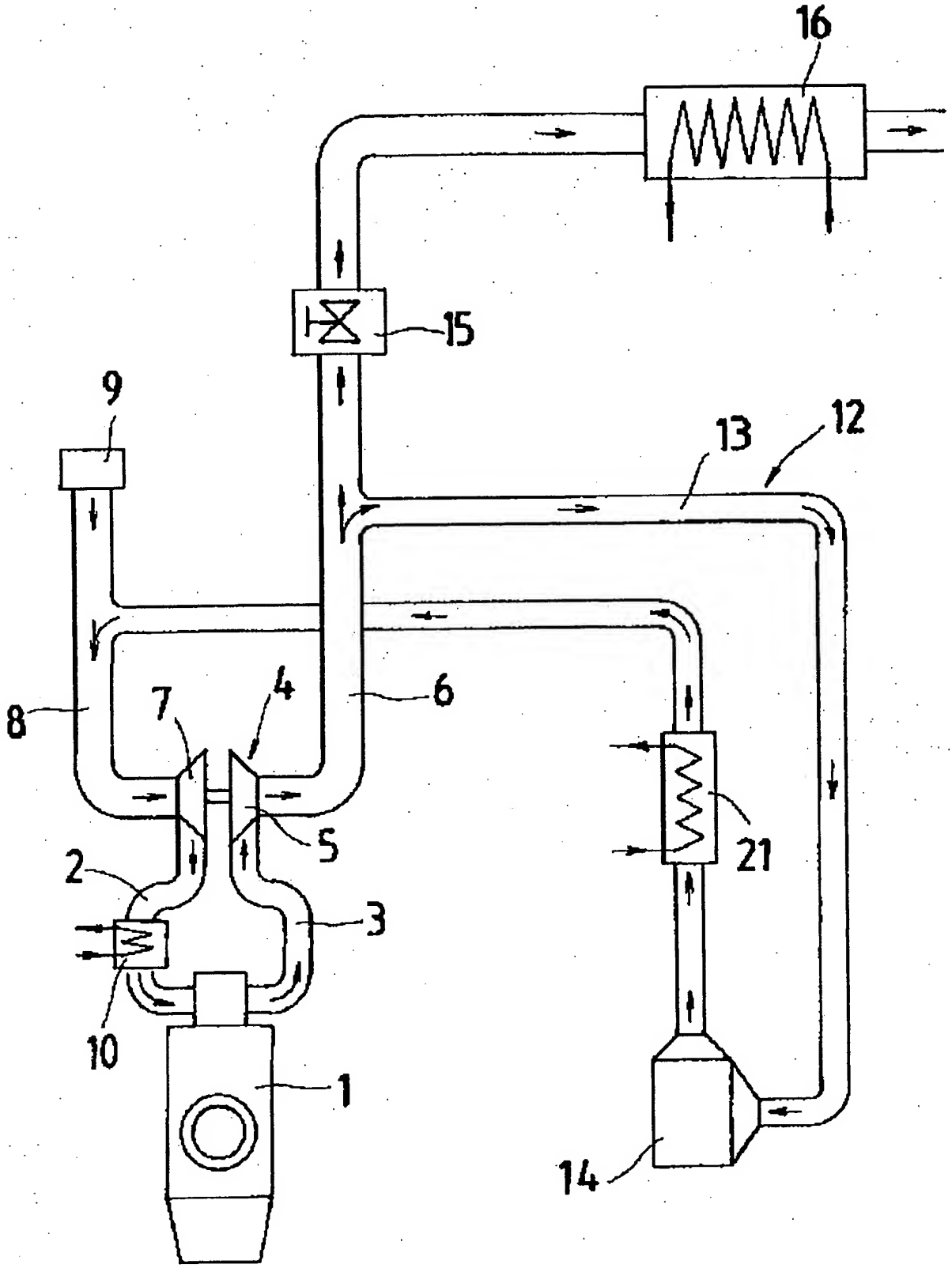
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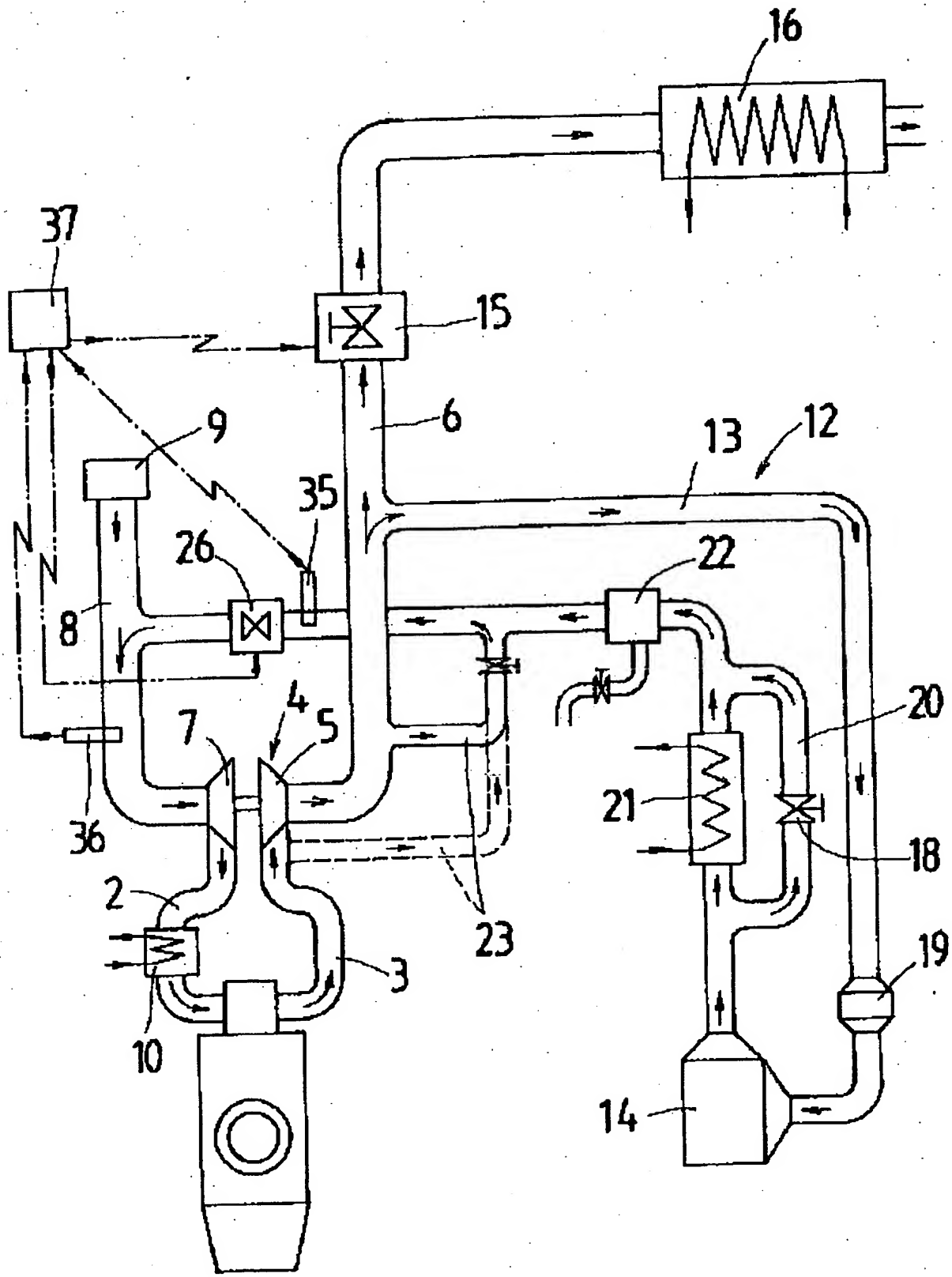
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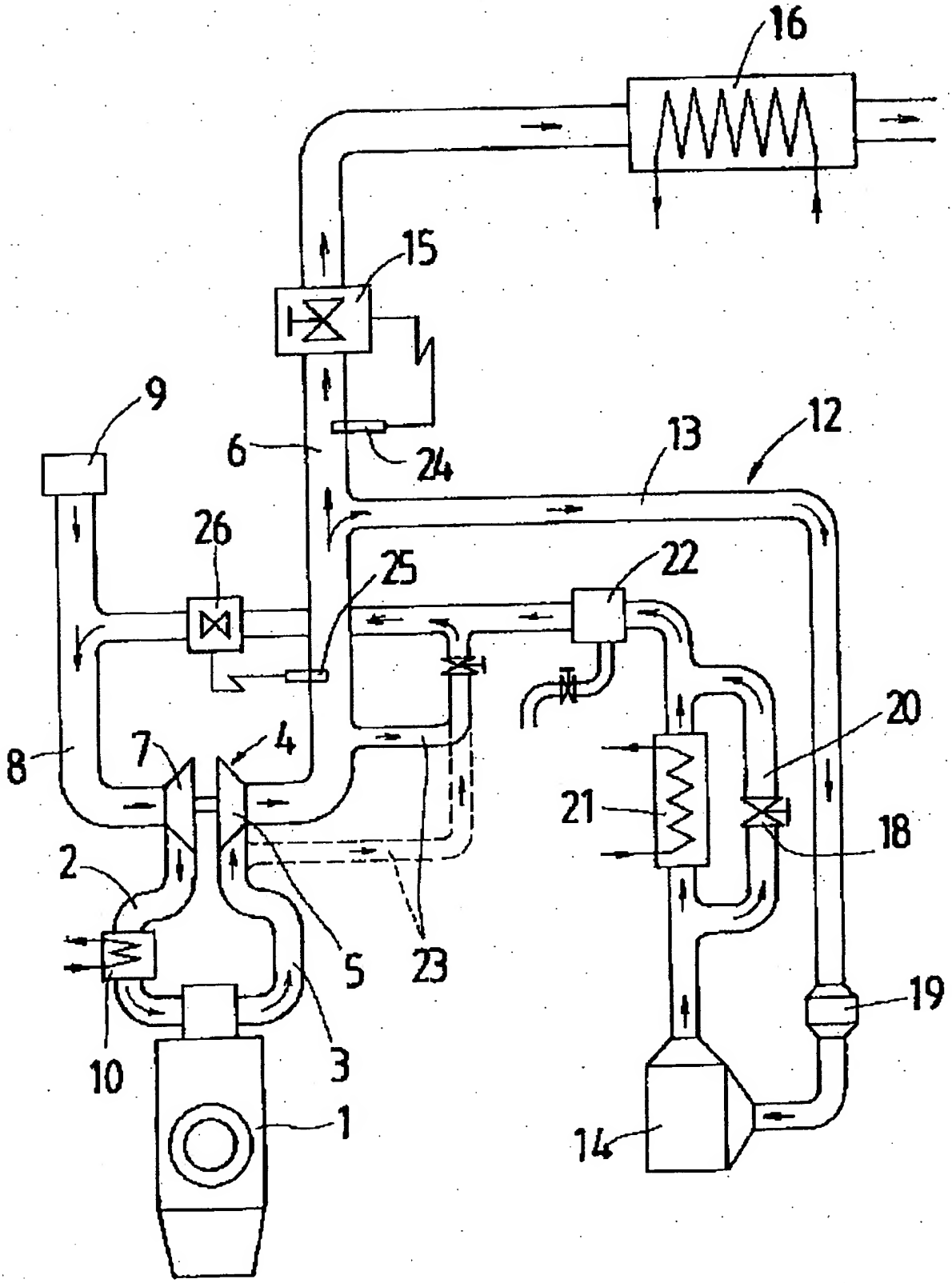
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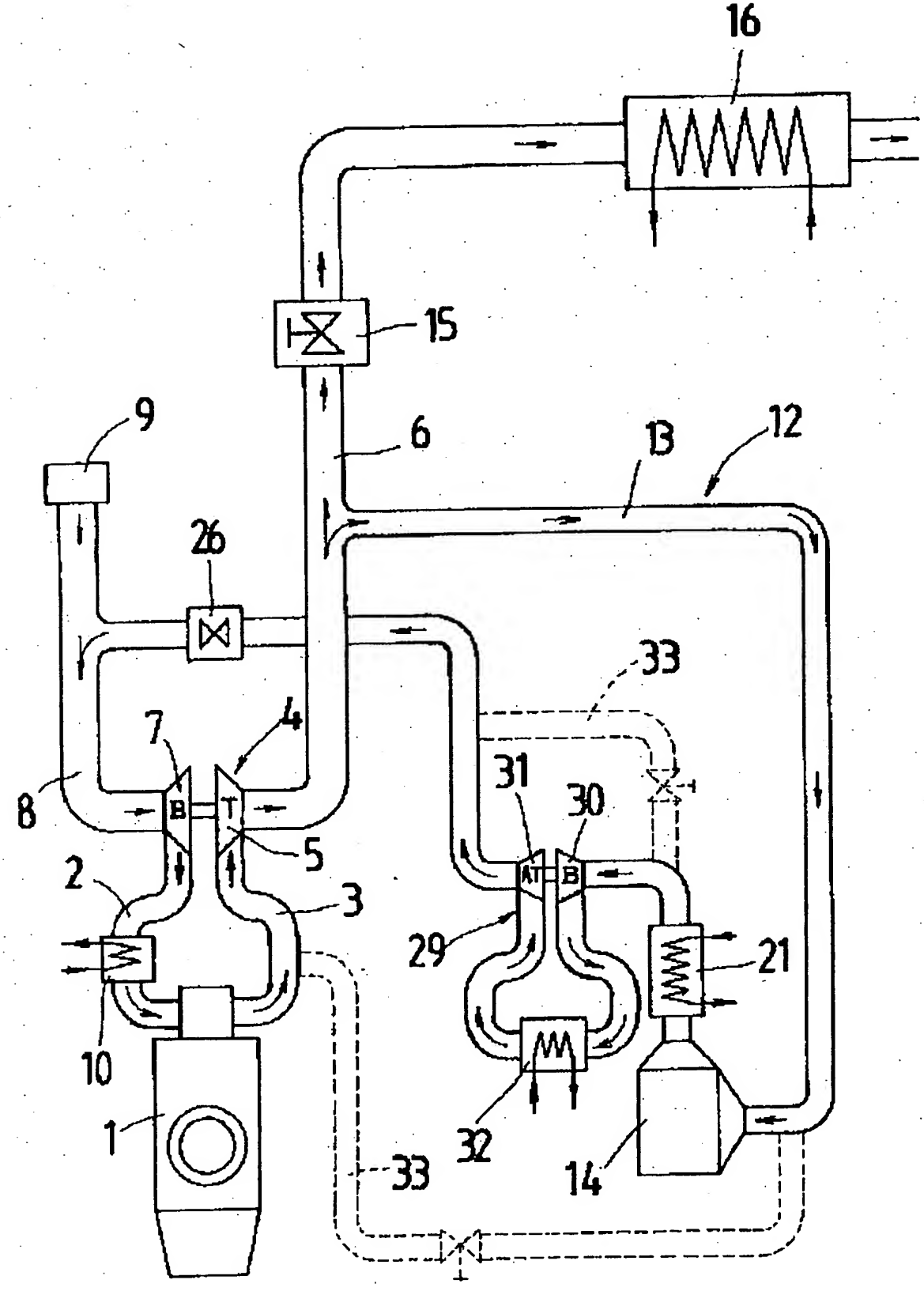
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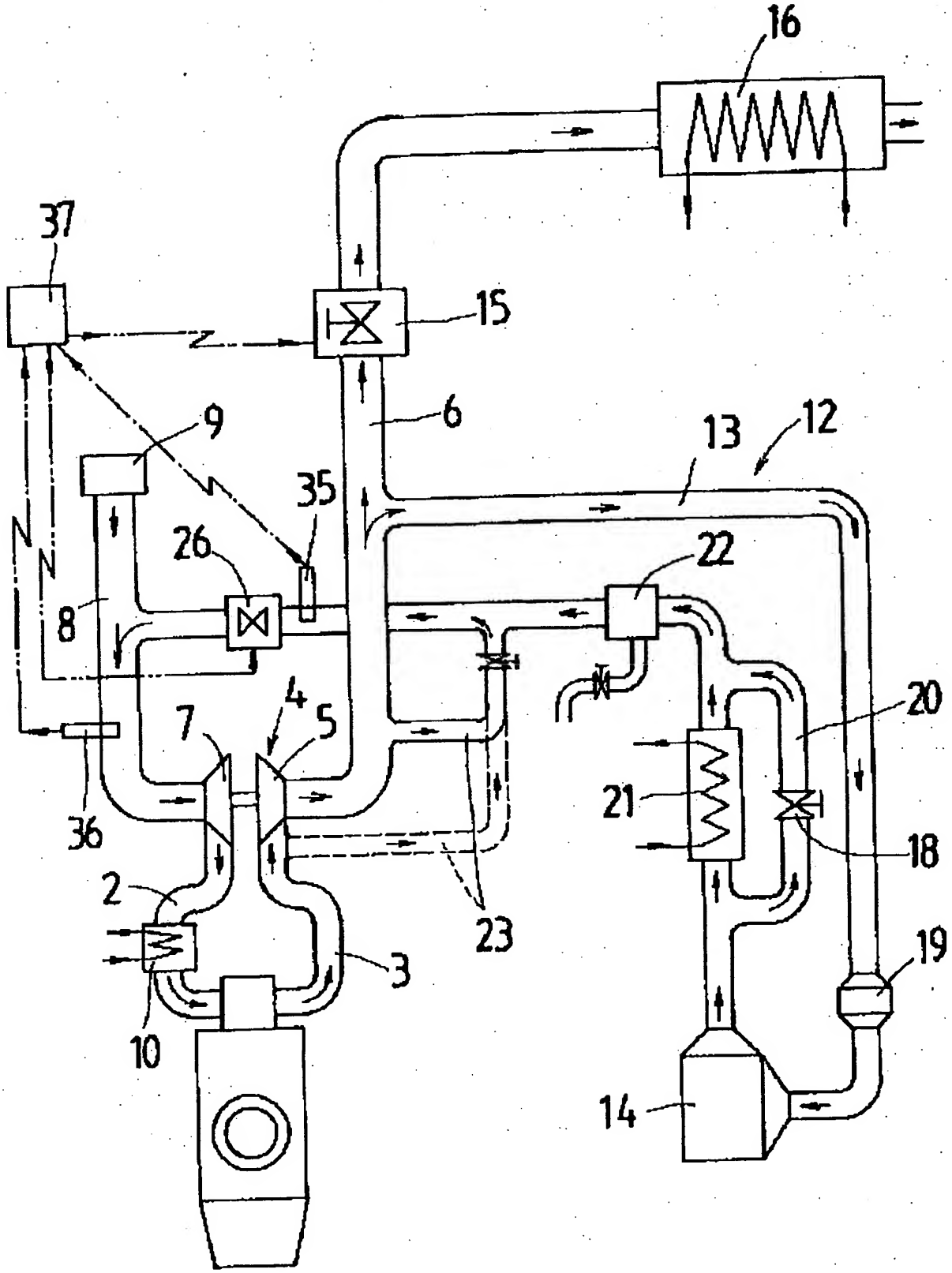
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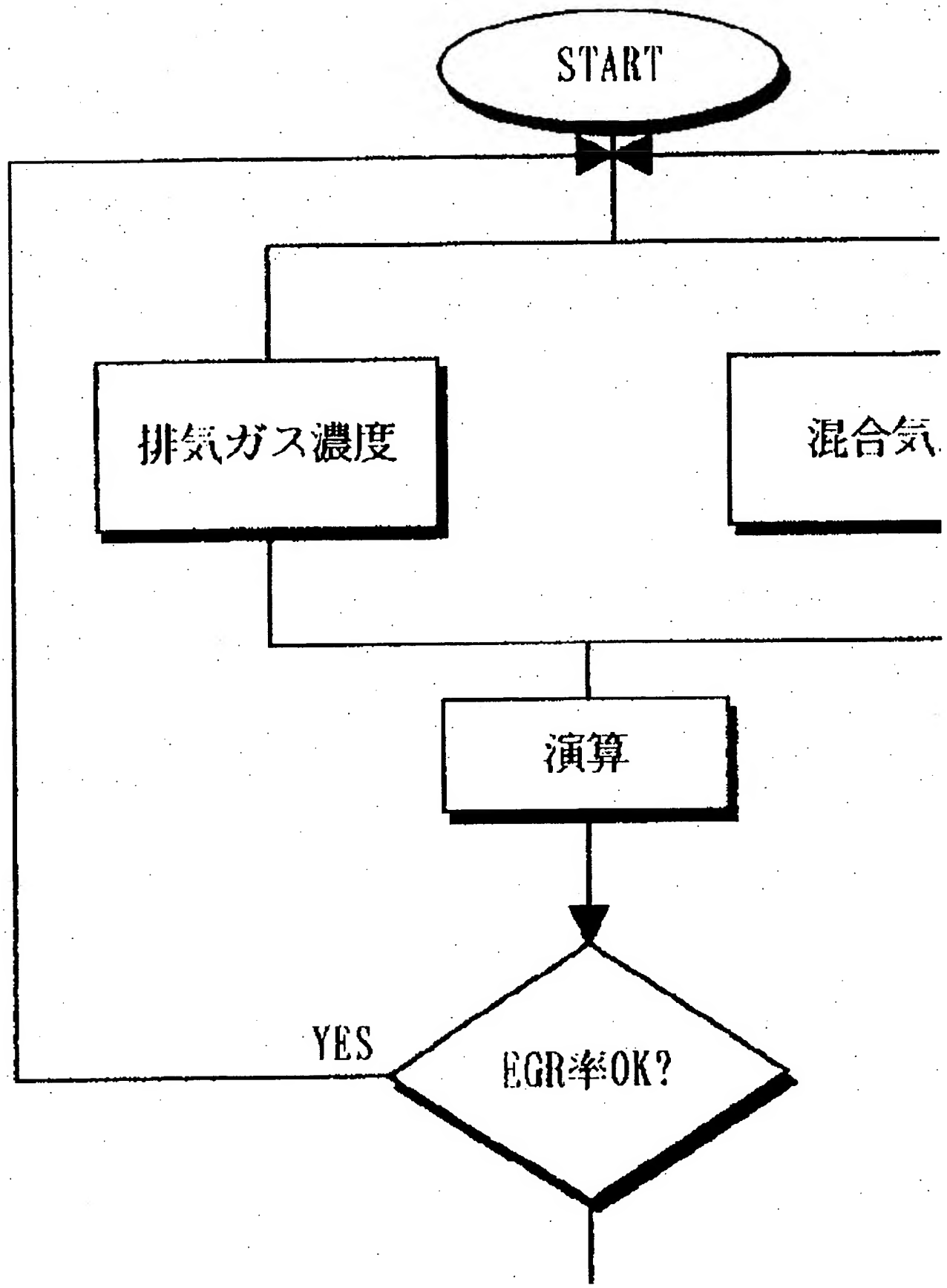
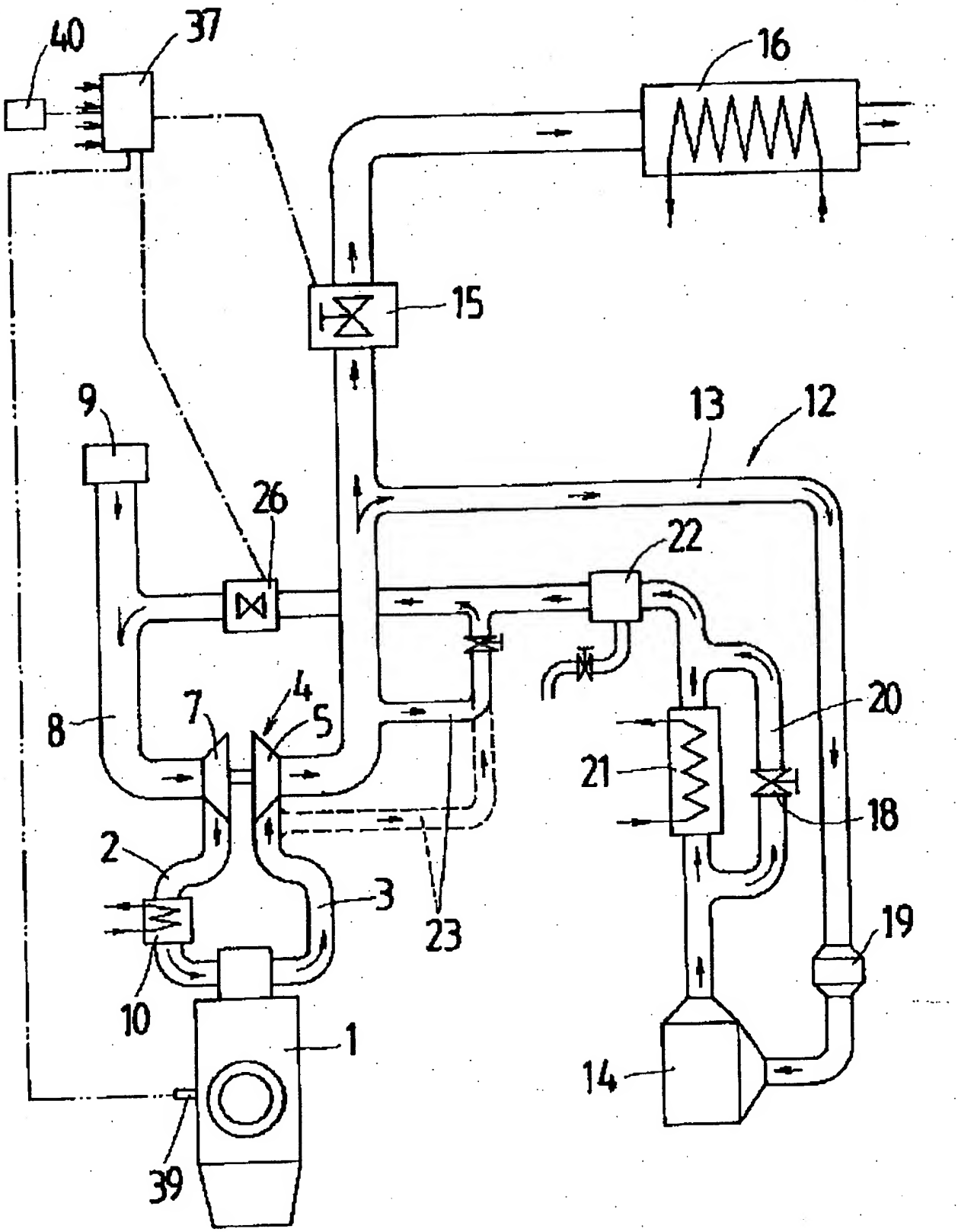

START
排気ガス濃度
混合気
演算
YES
EGR率OK?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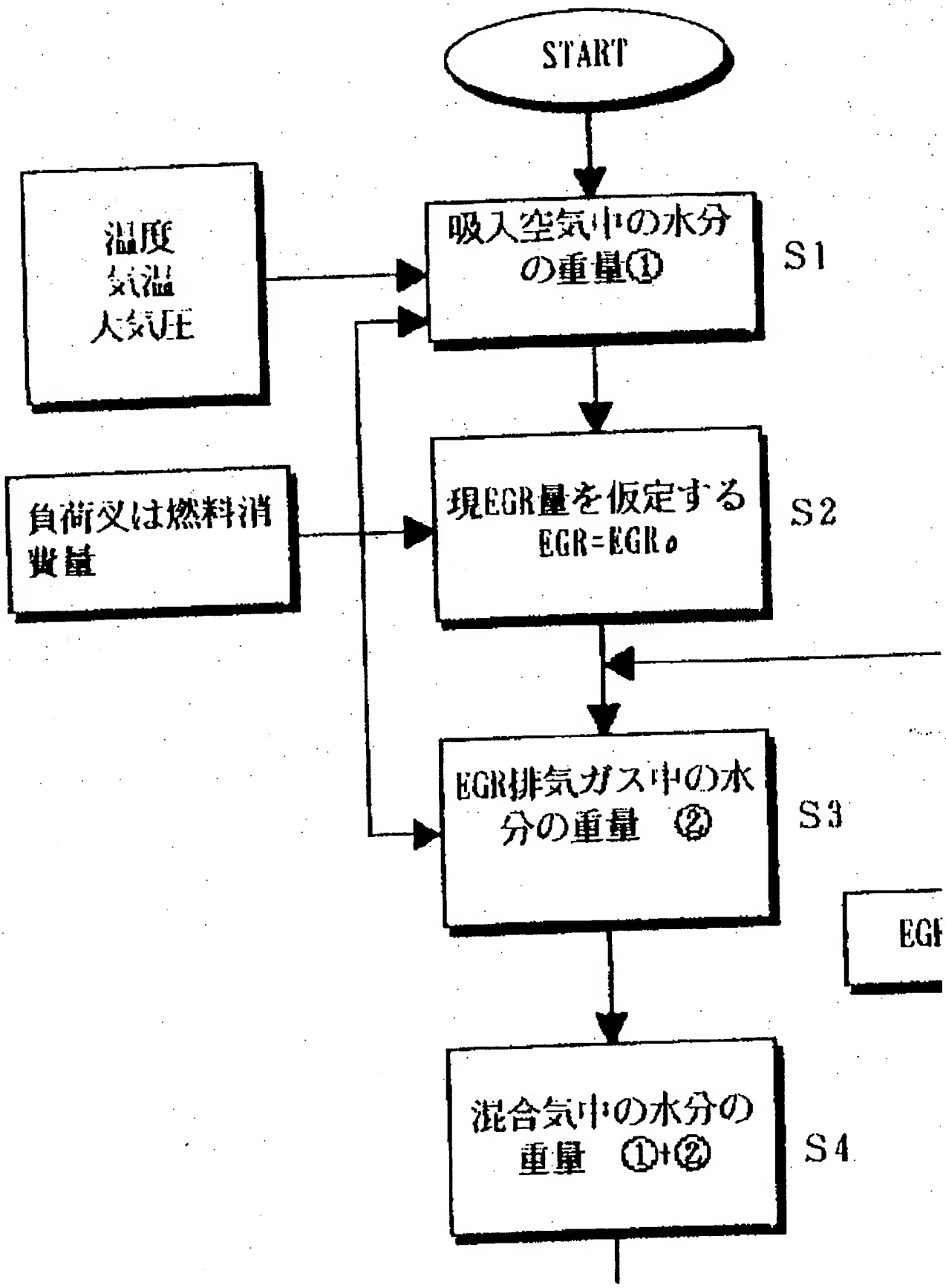
START
温度
気温
大気圧
吸入空気中の水分の重量①
S1
負荷又は燃料消費量
現EGR量を仮定する
EGR=EGR0
S2
EGR排気ガス中の水分の重量 ②
S3
EGI
混合気中の水分の重量 ①+②
S4